CHAPTER 3

PRESENT WORTH CALCULATIONS: CONVENTIONAL APPROACH

3-1. Introduction.

Current provisions of criteria, as set forth in' chapter 2, require that cash flows in economic studies for MCP projects be combined and compared via present worth discounting. The conventional approach to the calculation of PWs is illustrated in this chapter. This approach is universal in the sense that it provides step-by-step procedures for computing the PW of any cost that may be encountered. Costs are here meant to include expenditures incurred and monetary benefits received (such as income, savings, and net salvage value). In accordance with the provisions of chapter 2, the unit of measurement for all costs is constant dollars as of the analysis base date. Only costs that are expected to occur on or after the date of the study are considered; costs incurred prior to the date of the study are sunk costs, which, in accordance with conventional practice, are not included in economic studies for MCP projects. In paragraph 3-2, the calculations of the conventional approach are outlined and used to find the PWs of several general types of costs. In paragraph 3-3, the approach is used to apply the criteria of chapter 2 to three typical MCP design alternatives. All simulated case histories presented in this chapter were developed in January 1982, and all utilize cost information that generally reflects market prices and cost-growth projections of that timeframe (see para 1-4).

3-2. Calculations.

In the conventional approach, each cost is escalated and discounted in separate steps as necessary to determine its present worth. With regard to frequency of occurrence, all costs are classified as either one-time costs or annually recurring costs. The general calculational approaches for the two types of costs are very similar in nature.

a. Classification of costs for calculations. The various costs that may be incurred over the lifetime of a construction project or design element may be considered to be of four types with respect to frequency of occurrence.

—*One-time* costs are costs that are incurred only once during the life of the project or element. Examples include initial investment costs, terminal costs (or net terminal values), and the costs of some alterations and replacements.

–*Continuous* costs are costs that will be incurred periodically throughout a given year. Examples include the costs of fuel/energy and operations (non-energy), some maintenance and repair costs, and custodial costs.

–*Cyclical* costs are costs that are expected to be incurred several times over the life of the project or element, but less often than once per year. Examples include some alteration, repair, and replacement costs and some maintenance costs.

–*Annually recurring* costs are costs that are expected to be incurred once each year during the life of the project or element.

For the purpose of calculating its present worth, a cyclical cost is treated as a series of one-time costs. For example, the cost of overhauling a certain piece of equipment every 3 years would be treated as a one-time cost occurring 3 years after BOD, another one-time cost occurring 6 years after BOD, and so on. Similarly, for a continuous cost, the amounts incurred over each 12-month period are summed, and the sum is treated as an *annually recurring* cost. For example, a semi-annual operating cost of $1,100 is treated as an annually recurring cost of $2,200. These two conventions reduce the number of cost frequency types from four to two, so that only a "two-track" procedure is required to determine the PWs of all costs involved in MCP projects. (It should be noted that a series of uniformly escalating annual costs may be treated as an annually recurring cost series, and that is how such series are treated in this manual.)

b. Calculations for one-time costs. The present worth (on the analysis base date) of a one-time cost (in base date dollars) is calculated as follows:

Step 1: Estimate the amount of one-time cost as of the base date, and the time at which it will occur.

Step 2: Escalate this cost to the time at which it is actually to be incurred, using the differential escalation rate e.

Step 3: Discount the escalated future one-time cost to an equivalent PW on the base date, using the discount rate d.

The examples that follow illustrate this procedure for several typical and special cases. Subparagraph (1) illustrates the typical case in which the escalation rate is zero. Subparagraphs (2) and (3) cover, respectively, cases in which the escalation rate is positive and negative. The case illustrated in subparagraph (4), in which a cost is incurred on the base date, is typical of the criteria of paragraphs 2-3 and 2-4. Finally, subparagraph (5) illustrates the case in which the escalation rate changes during the anaylsis period. The data and calculations for these examples are organized on a sample worksheet (fig 3-1) taken from the full worksheet. The full worksheet in DA Form 5605-4-R (Life Cycle Cost Analysis Savings—To–Investment Ratio (SIR) and Discounted Payback Calculation). DA Forms 5605-R through 5605-5-R will be used for calculations of LCCAs. These forms will be locally reproduced on 8-1/2" x 11" paper. Copies for local reproduction purposes are located in the back of this manual. All results are rounded to an appropriate number of significant figures. (Use of the full worksheet is illustrated in para 3-3 and in chap 6.)

(1) Example: e = O. A $3,000 cost (estimated as of the base date) will actually be incurred 15 years from the base date. The cost is not expected to escalate at a rate greater than the general inflation rate, so the differential escalation rate e is zero. The discount rate is 10 percent. The PW of this cost is calculated as follows (the steps are illustrated in fig- 3-1):

Step 1: Enter a brief description of the cost, the number of years from the base date to cost incurrence, and the estimate of the cost on the base date. Check the appropriate box to indicate the dollar magnitude, or leave the boxes blank to denote "no multiplier."

Step *2:* Calculate the escalation factor as (1 + e)", where e is the escalation rate expressed as a decimal, and n is the number of years from the base date to the time of the expenditure; or, obtain it from table B-3. Here, the escalation factor is $(1 + 0.00)^{15}$ or 1.0. Enter this factor, and then multiply it by the cost on the base date to establish the escalated cost at year 15 as 1.0 x 3.0 = 3.0.

Step *3:* Calculate the discount factor as 1/(1 + d)" or [1/(1 + d)]", where d is the discount rate expressed as a decimal; or, obtain it from table B-4. There, the discount factor is $1/(1 + 0.10)^{15}$ or 0.2394. Enter this factor, and then multiply it be the escalated cost to obtain the present worth (as of the base " date) of 0.2394 x 3.0 = 0.72 or $720.

Given the long discounting period (15 years) and the O percent escalation rate, this result–a PW that is about one-quarter of the original base date cost—seems reasonable.

(2) Example: positive escalation rate. The data for a certain cost are: base date cost = $3,000; cost incurred 15 years after base date; e = +3 percent; d = 10 percent. The following steps are illustrated in figure 3-1:

Step 1: Enter input data (as in previous example).

Step 2: $(1 + e)^n = (1 + 0.03)^{15} = 1.558$ (or obtain from table B-3) 1.558 x 3.0 = 4.67

Step 3: $1/(1 + d)^n = 1/(1.1)^{15} = 0.2394$ (or obtain from table B-4) 0.2394 X 4.67 = 1.12 = $1,120

(3) Example: negative escalation rate. The data for a certain cost are: base date cost = $3,000; cost incurred 15 years after base date; e = – 3 percent, d = 10 percent. The following steps are illustrated in figure 3-1:

Step 1: Enter input data (as in previous examples).

Step 2: $(1 + e)^n = (1 - 0.03)^{15} = (0.97)^{15}$ = 0.633 (or obtain from table B-3)
0.633 X 3.0 = 1.90

Step 3: $1(1 + d)^n = 1/(1.1)^{15} = 0.2394$ (or obtain from table B-4) 0.2394 x 1.90 = 0.45 = $450

A negative escalation rate increases the effect of discounting so that this result is much smaller than the result of subparagraph (2) above.

(4) Example: cost incurred on base date is $75,000; e = 5 percent, d = 7 percent. The following steps are illustrated in figure 3-1:

Step 1: Enter input data (as in previous examples).

Step 2: (1 + e)" = $(1 + 0.05)^0$ = 1.00
1.00 x 75.0 = 75.0

Step 3: 1/(1 + d)" = 1/(1.07)0 = 1.00
1.00 x 75.0 = 75.0 = $75,000

The reason for the equality of the cost as estimated at the base date and its PW as of the base should be obvious. Since no time elapses between cost estimation and cost incurrence (n = O), the cost can neither escalate nor be dis-

CHAPTER 4

PRESENT WORTH CALCULATIONS: ONE-STEP APPROACH

4-1. Introduction.

The one-step approach to present worth calculations is an alternative to the conventional approach covered in chapter 3. Its greatest advantage is simplicity. In the conventional approach, for example, it is necessary to represent each recurring annual fuel/energy cost series by several subseries. Not only are separate PW calculations required for each of these subseries (for each fuel/energy type), but in addition the number of payments in the cost series that; fall into each "escalation time zone", the date on which the first payment in each time zone is incurred, and the time between that date and the ABD must be calculated. In the one-step approach, the subseries representation is not required, thus eliminating the need for all these extra calculations. In addition, the number of table lookups, interpolations, and multiplications for each PW calculation is reduced significantly in the one-step approach. All that is required for each PW calculation-in essence—is a single table lookup to determine a single factor—the one-step adjustment factor *(OSAF)* or simply the *adjustment factor.* Tables of adjustment factors ("one-step" tables) for all of the commonly occurring types of costs encountered in MCP applications-i. e., for one-time costs with a zero differential escalation rate, for annually recurring costs with a zero differential escalation rate, and for annually recurring energy/fuel costs with differential escalation rates projected by the DOE (for FEMP applications)–have been developed, and are available by request, through normal channels, to HQDA (DAEN-ECE-G), WASH, DC 20314-1000. These tables will be updated and kept current, as required (e.g., each time the DOE develops and publishes revised differential escalation rates for fuel and energy prices for FEMP, and The Office of the Secretary of Defense authorizes/directs their adoption for DoD applications). *(Sample* one-step tables are provided in this chapter, where they are used in conjunction with the examples presented.) In any situation that is not covered by the one-step tables, the conventional approach of chapter 3 may be used. The scope and applications of the one-step approach are illustrated in this chapter. In paragraph 4-2 the approach is outlined and used to find the PWS of some of the same general types of costs as are covered in paragraph 3-2. In paragraph 4-3 the approach is used to apply the criteria of chapter 2 to the same MCP design alternatives that are treated in paragraph 3-3. The examples in these paragraphs point up both the ease of application of the one-step approach and its major disadvantage: the procedure is so simplified that there may be a loss of sensitivity to the significance of PW calculations and their results. All simulated case histories presented in this chapter were developed in January 1982, and all utilize cost information that generally reflects market prices and cost growth of that time frame (see para 1-4). (It should be noted that the uniform-present-worth (UPW) factors for M&R costs and the modified uniform-present-worth (UPW*) factors for fuel/energy costs provided for in the FEMP criteria are in essence non-normalized OSAFs. These are readily converted to OSAFs by dividing them by the number of payments in the series, or number of years in the study period.)

4-2. Calculations.

In the one-step approach, the PW for any cost element is obtained as the product of a *nominal total cost* for that element and a tabulated *one-step adjustment factor,* corrected as necessary with a *DOS correction factor.* (The nominal cost, adjustment factor, and correction factor are defined below.) With regard to frequency of occurrence, all costs are classified as either one-time costs or annually recurring costs. The general calculational approaches for the two types of costs are very similar in nature.

a. Classification of costs for calculations. As discussed in more detail in paragraph 3-2a, the costs related to construction projects and design elements may be considered to be of four types with respect to frequency of occurrence: one-time costs, cyclical costs, annually recurring costs, and continuous costs. By convention, in determining present worths, a cyclical cost is treated as a series of one-time costs; similarly, the amounts incurred for a continuous cost are summed over each 12-month period, and the sum is treated as an annually recurring cost. These conventions reduce the number of cost frequency types to two. However, three separate sets of tables of one-step adjustment factors are required to calculate the PWs of these two types of costs, as follows:

–Tables for one-time costs.

–Tables for annually recurring costs other than energy/fuel costs (e.g. M&R).

–Tables for annually recurring energy/fuel costs.

The need for three distinct sets of tables stems from the varying requirements of the criteria of chapter 2. In fact, the tables are formulated for use with specific criteria—either HQDA criteria or FEMP criteria-and will be updated as these criteria change. However, all the tables are used in approximately the same way in the one-step approach.

b. Calculations for one-time costs. The present worth (on the analysis base date (ABD)) of a one-time cost (in base date dollars) is calculated as follows:

Step 1: Estimate the amount of the one-time cost as of the base date, and the time at which it will occur.

Step 2: Use the appropriate adjustment factor (from the appropriate one-step table) to determine the PW of the cost on the base data.

Each factor in one-step tables for one-time cost (fig 4-1 for example) is the ratio of the actual PW of a one-time cost at the ABD (taking into account cost growth, if any, and the time value of money) to the nominal value of that one-time cost (ignoring cost growth and the time value of money), both expressed in constant ABD dollars. The significance of this factor is best understood when it is viewed as a percentage of the nominal cost. For example, a factor of 0.7513 indicates that the actual PW of the one-time cost in question (on the ABD) is approximately 75 percent of the nominal value of that one-time cost. Initial investment cost factors are generally high. Later replacement cost factors are lower. Salvage-related factors are very low. (Normally, adjustment factors do not exceed 1.0 ·(100 percent) although they can in unusual situations.) The procedure given above simply requires that the pertinent ratio be found in the tables and then multiplied by the nominal cost—which here is the cost as of the base date. The examples that follow illustrate this procedure for typical cases. Those in subparagraph (1) deal with one-time costs to be incurred prior to the BOD (but after the DOS), and those in subparagraph (2) with one-time costs to be incurred after the BOD. These examples are followed (in subpara (3)) by a short discussion on the treatment of special cases not covered by the one-step table. The data and calculations for the examples are organized on a sample worksheet (figure 4-2) taken from the full worksheet, and results are rounded to an appropriate number of significant figures. The full worksheet is DA Form 5605-5-R (Life Cycle Cost Analysis—Present Worth: One-Step Approach), and use of the full worksheet is illustrated in paragraph 4-3 and in chapter 6. DA Form 5605-5-R will be used for present worth calculation by conventional approach.

(1) Example: pre-BOD cost, e = 0. A cost of $13,500 in 1 January 1982 dollars (or $13,000 in 1 July 1981 dollars) is expected to be incurred on 1 January 1985, 3 years after the DOS of 1 January 1982. The BOD is projected to be 1 July 1985. The cost is not expected to escalate at a rate greater than the general inflation rate. The adjustment factor for this cost depends on the applicable criteria—that is, on whether the analysis is being conducted according to HQDA criteria (para 2-2, 2-5, and 2–6) or FEMP criteria (para 2-3 and 2-4).

(a) HQDA criteria and methodology. In an analysis conducted according to HQDA criteria, the ABD is taken to be 1 January 1982 (the DOS). The PW of this cost is found as follows (the steps are illustrated in figure 4-2):

Step 1: Enter a brief description of the cost, the number of years from the base date of 1 January 1982 to cost incurrence (3), and the $13,500 estimate of the cost at the base date. Check the appropriate box to indicate the dollar magnitude, or leave the boxes blank to denote "no multiplier."

Step 2: Obtain the adjustment factor from the HQDA criteria column of one-step table 1 (fig 4-l). The factor for "3 years after ABD" is 0.7513. Enter this factor, and then multiply it by the base date cost to obtain a PW of 0.7513 x 13.5 = 10.1 or $10,100 as of the base date.

(b) FEMP criteria and methodology. In an analysis conducted according to FEMP criteria, the ABD and BOD are taken to be 1 July 1981 (the FEMP-prescribed base date) and all costs incurred in that timeframe (between the ABD and the BOD) are assumed to have been incurred on that date. The amount of the cost as of this date is $13,000. Its PW is found as follows — (the steps are illustrated in fig 4-2):

ALL REGIONS ONE TIME COSTS

ONE STEP ADJUSTMENT FACTORS

FEMP METHODOLOGY		HQDA METHODOLOGY	
TIME COST INCURRED (YEARS AFTER AOD)	PER FEMP CRITERIA <1>	TIME COST INCURRED(YEARS AFTER AOD)	PER HQDA CRITERIA <2>
0.	1.0000	0.	1.0000
1.0	0.9346	1.0	0.9091
2.0	0.8734	2.0	0.8264
3.0	0.8163	3.0	0.7513
4.0	0.7629	4.0	0.6830
5.0	0.7130	5.0	0.6209
6.0	0.6663	6.0	0.5645
7.0	0.6227	7.0	0.5132
8.0	0.5820	8.0	0.4665
9.0	0.5439	9.0	0.4241
10.0	0.5083	10.0	0.3855
11.0	0.4751	11.0	0.3505
12.0	0.4440	12.0	0.3186
13.0	0.4150	13.0	0.2897
14.0	0.3878	14.0	0.2633
15.0	0.3624	15.0	0.2394
16.0	0.3387	16.0	0.2176
17.0	0.3166	17.0	0.1978
18.0	0.2959	18.0	0.1799
19.0	0.2765	19.0	0.1635
20.0	0.2584	20.0	0.1486
21.0	0.2415	21.0	0.1351
22.0	0.2257	22.0	0.1228
23.0	0.2109	23.0	0.1117
24.0	0.1971	24.0	0.1015
25.0	0.1842	25.0	0.0923
26.0	0.1722	26.0	0.0839
27.0	0.1609	27.0	0.0763
28.0	0.1504	28.0	0.0693
29.0	0.1406	29.0	0.0630
30.0	0.1314	30.0	0.0573
35.0	0.0937	35.0	0.0356
40.0	0.0668	40.0	0.0221
45.0	0.0476	45.0	0.0137
50.0	0.0339	50.0	0.0085
0.25	0.9832	0.25	0.9765
0.50	0.9667	0.50	0.9535
0.75	0.9505	0.75	0.9310

NOTES

<1> FIGURES BASED ON 7% DISCOUNT RATE
<2> FIGURES BASED ON 10% DISCOUNT RATE

Figure 4-1. Adjustment factors for one-time costs (one-step table 1).

Step 1			Step 2	
One-Time Costs [X] $ x 10^3 [ ] $ x 10^6	Years from ABD	Cost On ABD	One Step Adj.Factor Table 1	Present Worth on ABD
Example #1				
Pre-BOD, e = 0				
(a) HQDA	3	13.5	0.7513	10.1
(b) FEMP	0	13.0	1.0000	13.0
Example #2				
Post BOD, e = 0				
(a) HQDA	15	3.0	0.2394	0.72
(b) FEMP	11.5	2.9	0.4593	1.3

Figure 4-2. One-time cost calculations.

Step 1: Enter the input data (as above). Note that the number of years from ABD is zero, in accordance with the FEMP criteria for all costs incurred prior to BOD.

Step 2: Obtain the adjustment factor from the FEMP criteria column of one-step table 1 (fig 4-1). The factor for "0 years after ABD" is 1.0. Enter this factor, and then multiply it by the base date cost of $13,000 to obtain a PW of 1.0 x 13.0 = 13.0 or $13,000 as of the base date.

(2) Example: post-BOD cost, e = 0. A cost of $3,000 in 1 January 1982 dollars (or $2,880 in 1 July 1981 dollars) is expected to be incurred on 1 January 1997, 15 years after the date of study of 1 January 1982 and 11.5 years after the BOD, which is projected to be 1 July 1985. The cost is not expected to escalate at a greater rate than the general inflation rate. Again, the PW of this cost depends on the applicable criteria (HQDA or FEMP).

(*a*) *HQDA criteria and methodology.* In an analysis conducted according to HQDA criteria, the ABD is taken to be 1 January 1982 (the DOS). The PW of this cost is determined as follows (the steps are illustrated in fig 4-2):

Step 1: Enter the input data, including the cost of $3,000 as of the base date.

Step 2: Obtain the adjustment factor from the HQDA criteria column of one-step table 1 (fig 4-1). Here the factor is 0.2394. Enter this factor; then multiply it by the base date cost to obtain a PW of 0.2394 x 3.0 = 0.72 or $720 as of the base date.

(*b*) *FEMP criteria and methodology.* In an analysis conducted according to FEMP criteria, the ABD and BOD are taken to be 1 July 1981 (the FEMP prescribed base date). The amount of the cost as of this date is $2,880 or approximately $2,900. According to FEMP criteria, the cost is assumed to be incurred on 1 January 1993 (11.5 years after the ABD), the date on which it would have been incurred had the BOD actually occurred on the ABD. Its PW is obtained as follows (the steps are illustrated in fig 4-2):

Step 1: Enter the input data (as above).

Step 2: Obtain the adjustment factor from the FEMP criteria column of figure 4-1. The factor for 11.5 years is 0.4593-the factor for 11 years, 0.4571, multiplied by the factor for 0.5 years, 0.9667, near the bottom of the table. (Note that straight-line interpolation in fig 4-1, between 11 years and 12 years, gives a slightly less accurate, but perfectly acceptable, value of 0.4596.) Enter this factor, and multiply it by the base date cost to obtain a PW of 0.4593 X 2.9 = 1.3 or $1,300 as of the base date.

(3) One-time cost situations not covered by the one-step table. The one-step table for one-time costs will not provide adjustment factors for the following cases:

– One-time cost situations in which the differential escalation rate is positive, negative, or variable (that is, situations in which e # O).
– Situations in which the cost at hand is to be incurred more than 50 years after the analysis base date.

The conventional approach of paragraph 3-2b may be used in all such cases. See, for example, paragraphs 3-2b(2) and (3).

c. Calculations for annually recurring costs. The general form of a series of uniformly escalating annual costs is shown in figure 3-2. The present worth (on the base date) of such a series of costs is found as follows:

Step 1: Estimate the amount A_0 of the annually recurring cost as of the base date, and determine the number of costs k in the series.

Step 2: Determine the *nominal total cost* as A_0k. Obtain the appropriate adjustment factor and correction factor from the appropriate one-step table and determine the PW of the series of costs by multiplying the nominal total cost by these factors.

Each adjustment factor in the one-step tables for annually recurring costs, M&R or energy (figs 4-3, 4-4 or 4-5 for example), is a ratio of the actual PW of a series of annually recurring costs at the ABD (taking into account cost growth, if any, and the time value of money) to the nominal total cost of the series (ignoring cost growth and the time value of money), both expressed in constant ABD dollars. The significance of this factor is best understood when it is viewed as a percentage of the nominal total cost. For example, a factor of 0.4661 indicates that the actual PW of the series of annually recurring costs is about 47 percent of the value of the nominal total cost of that series. The one-step adjustment factors for annually recurring costs are tabulated based on the assumption that the ABD corresponds to the most recent FEMP-directed base date (as prescribed in 10 CFR 436A). For all analyses governed by the FEMP criteria (see para 2-3 and 2-4), the assumption is automatically valid, and the tabulated factor is used directly. For all analyses governed by the HQDA criteria, however (see para 2-2, and 2-5), the assumption must be considered to be invalid, since in these types of analyses the ABD is set to correspond to the date of the study (DOS), and the DOS normally occurs after the FE MP-prescribed base date. Accordingly, in these types of analyses, the tabulated adjustment factors must be corrected—to account for the difference in time between the FEMP-directed base date and the DOS. Fortunately, the correction is a simple one to make, and the correction factors to be used are readily available. In fact, each of the one-step tables for annually recurring costs contains the correction factor that is appropriate for the data in that particular table. (Refer to the DOS correction factor at the bottom of the table.) The examples that follow illustrate the use of the one-step approach for PW calculations for several typical cases. Those in subparagraph (1) deal with annual costs for which e = O (e.g., M&R costs, in general), and those in subparagraph (2) deal with annual fuel/energy costs, for which e values are specifically prescribed. The data and calculations for each example are organized on a sample worksheet (fig 4-6), and results are rounded to an appropriate number of significant figures. The full worksheet is DA Form 5605-5-R, and use of the full worksheet is illustrated in paragraph 4-3 and in chapter 6.

(1) Example: e = 0. An annually recurring cost which is estimated as $5,000 (in constant ABD dollars) will be incurred each year for the 25-year projected economic life of the facility. The cost is not expected to escalate at a rate greater than the general inflation rate (e = O). The date of the study (DOS) is 1 January 1982, and the BOD is projected to be 1 January 1985. The PW of this series of costs depends on the applicable criteria—that is, on whether the analysis is being conducted according to HQDA (para 2-2, 2-5, and 2-6) or FEMP criteria (para 2-3 and 2-4).

ALL REGIONS

MAINTENANCE AND REPAIR (M&R) <4>

ONE STEP ADJUSTMENT FACTORS

ANALYSIS PERIOD (NUMBER OF) (PAYMENTS)	BENEFICIAL OCCUPANCY DATE: <1> PER FEMP	PER HQDA AS PROJECTED <2>								
	1 JUL 81	1 JUL 83	1 JUL 84	1 JUL 85	1 JUL 86	1 JUL 87	1 JUL 88	1 JUL 89	1 JUL 90	1 JUL 91
10	0.7024	0.5326	0.4842	0.4402	0.4002	0.3638	0.3307	0.3006	0.2733	0.2485
15	0.6072	0.4395	0.3996	0.3632	0.3302	0.3002	0.2729	0.2481	0.2255	0.2050
20	0.5297	0.3590	0.3354	0.3049	0.2772	0.2520	0.2291	0.2083	0.1893	0.1721
25	0.4661	0.3147	0.2861	0.2601	0.2364	0.2150	0.1954	0.1776	0.1615	0.1468
30	0.4136	0.2724	0.2476	0.2251	0.2046	0.1860	0.1691	0.1537	0.1398	0.1271
50	0.2760	0.1719	0.1563	0.1420	0.1291	0.1174	0.1067	0.0970	0.0882	0.0802
DATE-OF-STUDY CORRECTION FACTOR	---	1.008 PER MONTH AFTER 1 JUL 81 <2> <3>								

NOTES

<1> FIGURES BASED ON 7% DISCOUNT RATE AND END-OF-YEAR CONVENTION
<2> FIGURES BASED ON 10% DISCOUNT RATE AND MIDDLE-OF-YEAR CONVENTION
<3> UNCORRECTED ADJUSTMENT FACTORS BASED ON ASSUMED BOS OF 1 JUL 81
<4> ADJUSTMENT FACTORS BASED ON ASSUMED DIFFERENTIAL ESCALATION RATE OF 0%

Figure 4-3. Adjustment factors for annually recurring M&R costs (one-step table 2).

REGION 4

ELECTRICITY

ONE STEP ADJUSTMENT FACTORS

ANALYSIS PERIOD (NUMBER OF) (PAYMENTS)	BENEFICIAL OCCUPANCY DATE: <1> PER FEMP	PER HQDA AS PROJECTED <2>								
	1 JUL 81	1 JUL 83	1 JUL 84	1 JUL 85	1 JUL 86	1 JUL 87	1 JUL 88	1 JUL 89	1 JUL 90	1 JUL 91
10	0.8517	0.6671	0.6184	0.5701	0.5237	0.4808	0.4410	0.4041	0.3699	0.3384
15	0.7554	0.5598	0.5175	0.4763	0.4372	0.4011	0.3677	0.3368	0.3083	0.2820
20	0.6700	0.4751	0.4387	0.4035	0.3703	0.3396	0.3112	0.2850	0.2608	0.2386
25	0.5970	0.4084	0.3769	0.3465	0.3179	0.2915	0.2671	0.2446	0.2239	0.2048
30	0.5348	0.3555	0.3279	0.3014	0.2765	0.2535	0.2323	0.2127	0.1947	0.1781
50	0.3650	0.2268	0.2091	0.1921	0.1762	0.1615	0.1480	0.1355	0.1240	0.1135
DATE-OF-STUDY CORRECTION FACTOR	---	1.0037 PER MONTH AFTER 1 JUL 81 <2> <3>								

NOTES

<1> FIGURES BASED ON 7% DISCOUNT RATE AND END-OF-YEAR CONVENTION
<2> FIGURES BASED ON 10% DISCOUNT RATE AND MIDDLE-OF-YEAR CONVENTION
<3> UNCORRECTED ADJUSTMENT FACTORS BASED ON ASSUMED BOS OF 1 JUL 81

Figure 4-4. Adjustment factors for annually recurring electricity costs (one-step table 3.4EL).

REGION 4

ONE STEP ADJUSTMENT FACTORS

DISTILLATE OIL

ANALYSIS PERIOD (NUMBER OF) (PAYMENTS)	BENEFICIAL OCCUPANCY DATE: <1> PER FEMP	PER HQDA AS PROJECTED <2>								
	1 JUL 81	1 JUL 83	1 JUL 84	1 JUL 85	1 JUL 86	1 JUL 87	1 JUL 88	1 JUL 89	1 JUL 90	1 JUL 91
10	0.8005	0.6331	0.5966	0.5643	0.5358	0.5106	0.4886	0.4695	0.4529	0.4379
15	0.7563	0.5700	0.5408	0.5145	0.4909	0.4697	0.4507	0.4338	0.4188	0.4049
20	0.7292	0.5212	0.4962	0.4735	0.4529	0.4341	0.4172	0.4019	0.3881	0.3752
25	0.7091	0.4803	0.4582	0.4380	0.4195	0.4027	0.3873	0.3732	0.3605	0.3485
30	0.6925	0.4448	0.4249	0.4067	0.3899	0.3745	0.3604	0.3474	0.3356	0.3245
50	0.6416	0.3383	0.3240	0.3108	0.2985	0.2871	0.2766	0.2668	0.2578	0.2492
DATE-OF-STUDY CORRECTION FACTOR	---	1.0059 PER MONTH AFTER 1 JUL 81 <2> <3>								

NOTES

<1> FIGURES BASED ON 7% DISCOUNT RATE AND END-OF-YEAR CONVENTION
<2> FIGURES BASED ON 10% DISCOUNT RATE AND MIDDLE-OF-YEAR CONVENTION
<3> UNCORRECTED ADJUSTMENT FACTORS BASED ON ASSUMED DOS OF 1 JUL 81
<4> ADJUSTMENT FACTORS BASED ON ASSUMED DIFFERENTIAL ESCALATION RATE OF 0%

Figure 4-5. Adjustment factors for annually recurring distillate oil costs (one-step table 3.4DO).

Step 1				Step 2	
Annual Costs ☒ $ x 10³ ☐ $ x 10⁶	Total No. of Payments	Annual Cost on ABD	Total Nominal Cost on ABD	One Step Adjustment Factor* Table Factor x DOS Correction	Present Worth on ABD
Example #1					
e = 0					
(a) HQDA	25	5.0	125.0	$0.2731 \times (1.008)^{6}$	35.8
(b) FEMP	25	5.0	125.0	0.4661	58.3
Example #2					
e = variable					
(a HQDA	25	5.0	125.0	$0.3465 \times (1.0037)^{12}$	45.3
(b) FEMP	25	5.0	125.0	0.5970	74.6

* Use one-step table 2, figure 4-3, for example 1;
use one-step table 3, figure 4-4, DOE region 4 (electricity) for example 2.

Figure 4-6. Annually recurring cost calculations.

(a) *HQDA criteria and methodology.* In an analysis conducted according to HQDA criteria, the PW of the annually recurring series of costs is calculated as follows (the steps are illustrated in fig 4–6):

Step 1: Enter a brief description of the cost, the annual cost amount A_0 estimated as of the base date, and the number of annual costs k in the series. Check the appropriate box to indicate the dollar magnitude, or leave the boxes blank to indicate "no multiplier."

Step 2: Compute the nominal total cost as A_0k = 5.0 X 25 = 125.0, and enter it. Interpolate between the 1 July 1984 and 1 July 1985 columns in the HQDA section of figure 4-3 to obtain the adjustment factor for the BOD of 1 January 1985. For k = 25 payments, this factor is 0.2601 + (1/2) (0.0260) = 0.2731; enter the factor. Obtain the correction factor as 1.008 raised to a power equal to the number of months between the first day of the FEMP base year as listed in table 2 (here, 1 July 1981) and the analysis base date (here, 1 January 1982). Since there are 6 months between these dates, the correction factor is (1.008)6. Compute the required PW as nominal total cost X adjustment factor X correction factor to obtain 125 X 0.2731 X $(1.008)^6$ = 35.8 or $35,800 as the PW (as of the base date) of the series of annually recurring costs.

This PW of $35,800 is very close to the $35,700 calculated using the conventional approach in paragraph 3-2c(1). (The difference of $100 is due to "rounding" of the results of calculations in the conventional method—specifically in the calculation of the equivalent single cost.)

(b) FEMP criteria and methodology. In an analysis conducted according to FEMP criteria, the PW of the annually recurring series of costs is obtained as follows (the steps are illustrated in fig 4-6):

Step 1: Enter input data (as above).

Step 2: Compute the nominal total cost as A_0k = 5.0 X 25 = 125, and enter it. Obtain the adjustment factor from the FEMP column of figure 4-3. For k = 25 payments, the adjustment factor is 0.4661; enter this factor. (There is no DOS correlation under the FEMP criteria, as indicated in the tables, and the tabulated factor is used directly.) Compute the PW as nominal total cost X adjustment factor to obtain 125 X 0.4661 = 58.3 or $58,300 as the PW (as of the base date) for the series of annually recurring costs.

This PW of $58,300 is very close to the $58,200 calculated using the conventional approach in paragraph 3-2c(2). (As in para 4-2c(l)(a), the difference is due to rounding-here again, in the calculation of the equivalent single cost.)

(2) Example: e variable. An annually recurring cost, which is estimated as $5,000 (in constant ABD dollars), will be incurred each year over the 25-year projected economic life of the facility. This cost is expected to escalate at the differential rates disseminated by HQDA and incorporated into the applicable energy-cost adjustment factors for electricity for DOE Region 4. The DOS is 1 July 1982, and the BOD is projected to be 1 July 1985. The PW of this series of costs depends on the applicable criteria (HQDA or FEMP).

(a) HQDA criteria and methodology. In an analysis conducted according to HQDA criteria, the PW of the series of costs is calculated as follows (the steps are illustrated in fig 4-6):

Step 1: Enter input data (as in previous examples).

Step 2: Compute the nominal total cost as A_0k = 5.0 X 25 = 125.0, and enter it. Obtain the adjustment factor from the 1 July 1985 column in the HQDA sections of fig 4-4. This factor is 0.3465; enter it on the worksheet. Obtain the correction factor as 1.0037 raised to a power equal to the number of months between 1 July 1981 and the date of study, 1 July 1982. Since the DOS follows 1 July 1981 by 12 months, the correction factor is (1.0037)12 = 1.045; enter this factor. Compute the required PW as nominal total cost X adjustment factor X correction factor to obtain 125 X 0.3465 X 1.045 = 45.3 or $45,300 as the PW (as of the base date) of the series of annually recurring costs.

This PW of $45,300 is very close to the $45,400 found with the conventional approach in paragraph 3-2c(5). (The slight difference is due to separate upward rounding of the PWs, to get to three significant figures, for each of the two subseries calculated by the conventional approach.)

(b) FEMP criteria and methodology. In an analysis conducted according to FEMP criteria, the PW of the annually recurring series of costs is obtained as follows (the steps are illustrated in fig 4-6):

Step 1: Enter input data (as in previous examples).

Step 2: Compute the nominal total cost as A_0k = 5.0 X 25 = 125, and enter it. Obtain the adjustment factor from the FEMP column of figure 4-4. Here, the adjustment factor is 0.5970; enter this factor. (There is no DOS correction under the FEMP criteria, as indicated in the tables, and the tabulated factor *is* used directly.) Compute the PW as nominal total cost X adjustment factor to obtain 125 X 0.5970 = 74.6 or $74,600 as the PW (as of the base date) for the series of costs.

This PW of $74,600 is very close to the $74,700 obtained with the conventional approach in paragraph 3-2c(6). Note the comparative ease with which it was computed. (The slight difference is due to the use of linear interpolation in table B-2 to obtain the annual series equivalence factors in paragraph 3-2c(6). The function tabulated, shown beneath the tabulated data, is clearly non-linear.)

(3) Annually recurring costs. Situations not covered by one-step tables. One-step tables for annually recurring costs will cover those cases where the value of e is assumed to be zero (fig

4-3, for example) and those cases where the value of e is assumed to vary as specified by the latest version of FEMP criteria (fig 4-4 and 4-5, for example). When these values of e are not applicable to a particular situation, PWs may be computed using the conventional approach of paragraph 3-2c. See, for example, paragrah 3-2c(3).

4-3. Illustrative analyses.

In this paragraph the procedures of paragraph 4-2 are applied to three typical MCP design alternatives included in an economic study for the Central Administration Building at ABCDE Ammunition Plant in Mississippi. The economic life projected for the facility is 25 years. The same alternatives are treated using the conventional approach in paragraph 3-3, so the two approaches can easily be compared. Since the basic input data are the same for both approaches, the input data worksheets of paragraph 3-3 are not repeated here. Only the one-step calculations are shown, organized on worksheets as they would be in a complete economic study. The one-step adjustment factors presented on the worksheets are taken from figure 4-1, figure 4-3, figure 4-4 or figure 4-5 either directly or by interpolation, as appropriate, The PWs developed with the one-step approach are equal for all practical purposes to those calculated by means of the conventional approach (para 3-3). The minor differences derive from rounding and interpolations from tabulated data.

a. Exterior closure. split face block. Figure 3-4 shows the basic input data for this alternative, and DA Form 5605-5-R (fig 4-7) shows the one-step PW calculations.

–Basic input data. See paragraph 3-3a(1) and figure 3-4.

—Present worth calculations. The sole one-time cost is the initial investment of $55,400; its PW is found with the procedure of paragraph 4-2 b(l)(a). The PW of the annually recurring maintenance and repair cost is calculated according to paragraph 4-2c(1)(a). The pertinent data and factors are recorded on the worksheet in figure 4-7; the multiplications are performed; and the results are summarized at the bottom of the worksheet.

b. HVAC system: conventional design. Figure 3-6 shows the basic input data for this alternative, and figure 4-8 shows the one-step PW calculations. The complete LCCA is discussed in chapter 6.

(1) Basic input data. See paragraph 3-3b(l) and figure 3-6.

(2) Present worth calculations. The PWs of the initial investment costs for the fan system and central plant are found with the procedure of paragraph 4-2 b(l)(a). In addition, the fans will have to be replaced 15 years after BOD, and a significant number of central plant components will require replacement 12' years after BOD. The PWs of the costs of these replacements are calculated as explained in paragraph 4-2b(2)(a). Once the replacements have been installed, the system is expected to have an economic life that extends beyond the analysis period. The system will, therefore, have a net salvage value that should be included in the analysis. The net salvage value is estimated by assuming straight-line depreciation, and the PW of this negative one-time post-BOD cost is computed in accordance with paragraph 4-2b(2)(a). The PWs of the annually recurring maintenance and repair costs are found as in paragraph 4-2c(l)(a), The PWs of the electricity and fuel costs (the one-step adjustment factors for distillate oil are shown in fig 4-5) are found in accordance with paragraph 4-2c(2)(a). The data and results are recorded and summarized as shown on the worksheet DA form 5605-5-R (fig 4-8).

c. Domestic water heating system: solar heating. Figure 3-8 shows the basic input data for this “alternative”, which represents the solar-energy portion only (i.e., the solar-energy "increment") of the domestic hot water (DHW) system as a whole. Figure 4-9 shows the PW computations. The complete LCCA, which illustrates the use of the incremental-analysis approach (per para 2-4c) is presented in appendix A, and is discussed in chapter 6.

(1) *Basic input data.* See paragraph 3-3c(1) and figure 3-8.

(2) *Present worth calculations.* The PW of the incremental initial investment cost (less the 10 percent investment credit) is found with the procedure of paragraph 4-2b(l)(b), since FEMP criteria (para 2-4) apply here. The PW of the incremental M&R cost is calculated according to paragraph 4-2c(l)(b), and the PW of the electricity cost savings according to paragraph 4-2c(b). The results of the calculations are summarized at the bottom of the worksheet DA Form 5605-5-R (fig 4-9):

Project No. & Title PN 175 (FY84) Admin. Bldg.
Installation & Location ABCDE Ammo. Plant, Miss.
Design Feature Exterior Closure
Alt. No. A Title Split Face Block

LIFE CYCLE COST ANALYSIS

PRESENT WORTH: ONE-STEP APPROACH

For use of this form, see TM 5-802-1; the proponent agency is USACE.

One-Time Costs ☒ $ x 10³ ☐ $ x 10⁶	Years from ABD	Cost On ABD	One Step Adj.Factor Table 1	Present Worth on ABD
Initial Investment Cost	2.5	55.4	0.7880	43.7

Criteria Reference	HQDA
Analysis Base Date (ABD)	1 Jan 82
Analysis End Date (AED)	1 Jan 10
Midpoint of Construction	1 Jul 84
BOD for Analysis	1 Jan 85
Annual Discount Rate	10%

Type of Cost	Differential Escalation Rate per Year (%) Timeframe: Jul - Jun 82-85	85-90	90-10
All	0.00	0.00	0.00

Annual Costs ☒ $ x 10³ ☐ $ x 10⁶	Total No. of Payments	Annual Cost on ABD	Total Nominal Cost on ABD	One Step Adjustment Factor* Table Factor x DOS Correction	Present Worth on ABD
M&R	25	0.5	12.5	$0.2731 \times (1.008)^6$	3.6

	Initial Costs		Energy/Fuel Costs		M&R Costs		Other Costs		Total
Net Present Worth:	43.7	+	0.0	+	3.6	+	0.0	=	47.3

DA FORM 5605-5-R, DEC 86

*Use One-Step Table 2 for M&R costs (e = 0).
Use One-Step Table 3 for energy/fuel costs (e = prescribed e value). Sheet_____ of_____

Figure 4-7. DA Form 5605-5-R, Present worth: one-step approach: exterior closure, split face block

Project No. & Title PN 175 (FY84) Admin. Bldg.

Installation & Location ABCDE Ammo. Plant, Miss.

Design Feature HVAC System — Conventional

Alt. No. A Title Const. Vol w/ Recip. Chiller

LIFE CYCLE COST ANALYSIS

PRESENT WORTH: ONE-STEP APPROACH

For use of this form, see TM 5-802-1; the proponent agency is USACE.

One-Time Costs [X] $ x 10^3 [ ] $ x 10^6	Years from ABD	Cost On ABD	One Step Adj.Factor Table 1	Present Worth on ABD
Initial Investment Cost	2.5	98.1	0.7880	77.3
Replacement - Plant yr. 12	15.0	45.0	0.2394	10.8
Replacement - Fan yr. 15	18.0	10.0	0.1799	1.8
Salvage yr. 25	28.0	-3.3	0.0693	- 0.2

Criteria Reference	HQDA
Analysis Base Date (ABD)	1 Jan 82
Analysis End Date (AED)	1 Jan 10
Midpoint of Construction	1 Jul 84
BOD for Analysis	1 Jan 85
Annual Discount Rate	10%

Type of Cost	Differential Escalation Rate per Year (%) Timeframe: Jul - Jun 82-85	85-90	90-10
Elect.	5.28	1.41	0.63
Dist. O.	2.52	2.64	6.35
Other	0.00	0.00	0.00

Annual Costs [X] $ x 10^3 [ ] $ x 10^6	Total No. of Payments	Annual Cost on ABD	Total Nominal Cost on ABD	One Step Adjustment Factor* Table Factor x DOS Correction	Present Worth on ABD
Elect.	25	16.5	412.5	$0.3617 \times (1.0037)^6$	152.5
Dist. O.	25	2.9	72.5	$0.4481 \times (1.0059)^6$	33.7
M&R	25	14.2	355.0	$0.2731 \times (1.008)^6$	101.7

	Initial Costs		Energy/Fuel Costs		M&R Costs		Other Costs		Total
Net Present Worth:	77	+	186	+	102	+	12	=	377

DA FORM 5605-5-R, DEC 86

*Use One-Step Table 2 for M&R costs (e = 0).
Use One-Step Table 3 for energy/fuel costs (e = prescribed e value).

Sheet ______ of ______

Figure 4-8. DA Form 5605-5-R Present worth: one-step approach: HVAC system, conventional.

Project No. & Title PN 175(FY84) Admin. Bldg.
Installation & Location ABCDE Ammo. Plant, Miss.
Design Feature Domestic Hot Water Heating System
Alt. No. B-A Title Solar System Increment

LIFE CYCLE COST ANALYSIS

PRESENT WORTH: ONE-STEP APPROACH

For use of this form, see TM 5-802-1; the proponent agency is USACE.

One-Time Costs ☒ $ x 10³ ☐ $ x 10⁶	Years from ABD	Cost On ABD	One Step Adj.Factor Table 1	Present Worth on ABD
Initial Investment Cost	0	54.0	1.0	54.0

Criteria Reference	FEMP
Analysis Base Date (ABD)	1 Jul 81
Analysis End Date (AED)	1 Jul 06
Midpoint of Construction	N.A.
BOD for Analysis	1 Jul 81
Annual Discount Rate	7%

Type of Cost	Differential Escalation Rate per Year (%) Timeframe: Jul-Jun 81-85	85-90	90-06
Elect.	5.28	1.41	0.63
Other	0.00	0.00	0.00

Annual Costs ☒ $ x 10³ ☐ $ x 10⁶	Total No. of Payments	Annual Cost on ABD	Total Nominal Cost on ABD	One Step Adjustment Factor* Table Factor x DOS Correction	Present Worth on ABD
Elect.	25	-6.5	-162.5	0.5970	-97.0
M&R	25	1.5	37.5	0.4661	17.5

	Initial Costs		Energy/Fuel Costs		M&R Costs		Other Costs		Total
Net Present Worth:	54.0	+	-97.0	+	17.5	+	0.0	=	-25.5

DA FORM 5605-5-R, DEC 86

*Use One-Step Table 2 for M&R costs (e = 0).
Use One-Step Table 3 for energy/fuel costs (e = prescribed e value).

Sheet ______ of ______

Figure 4-9. DA Form 5605-5-R Present worth: one-step approach: domestic hot water heating system, solar system increment.